

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (Currently Amended) An apparatus comprising:
a fiducial marker including:
an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;
a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and wherein the conical receptacle is configured with a base at an edge defined by an exterior [[a]] surface of the locator head and a substantially continuously sloping wall to an apex at a center of the locator head to permit access to a center of the imagable fiducial locator head; and
a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone.
2. (Original) The apparatus of claim 1, in which the receptacle includes a substantially conical divot including an apex that is integrally located, with respect to the imagable fiducial locator head, such that a center of an image of the imagable fiducial locator substantially coincides with the apex of the divot.

3. (Original) The apparatus of claim 2, further including at least one slot in the imagable fiducial locator head, the at least one slot being sized and shaped for receiving a blade or tip of a screwdriver for turning and threading the bone screw shaft into the bone.

4. (Original) The apparatus of claim 1, further including at least one slot in the imagable fiducial locator head, the at least one slot being sized and shaped for receiving a blade or tip of a screwdriver for turning and threading the bone screw shaft into the bone.

5. (Original) The apparatus of claim 1, in which the imagable fiducial locator head is substantially spherical.

6-7. (Canceled)

8. (Original) The apparatus of claim 1, in which the imagable fiducial locator includes a reflective outer surface that reflects electromagnetic energy.

9. (Original) The apparatus of claim 1, in which the imagable fiducial locator is locatable by at least two different imaging modalities.

10. (Previously Presented) An apparatus comprising:

a fiducial marker including:

an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone;

wherein the imagable fiducial locator includes a hygroscopic material.

11. (Previously Presented) An apparatus comprising:
- a fiducial marker including:
 - an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;
 - a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head;
 - a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone; and
 - a seat in at least one of the imagable fiducial locator head and the shaft, the seat including a kerf.
12. (Original) The apparatus of claim 1, further including an imagable plug, sized and shaped to fit within the receptacle.
13. (Original) The apparatus of claim 1, further including a cover sized and shaped to fit over the imagable fiducial locator head.
14. (Original) The apparatus of claim 1, further including an imagable coating on at least a portion of the imagable fiducial locator head.

15. (Original) The apparatus of claim 1, in which at least a portion of the bone screw shaft is self-tapping.

16. (Original) The apparatus of claim 1, in which at least a portion of the bone screw shaft includes a bone cutting edge.

17. (Original) The apparatus of claim 1, in which the fiducial marker is a unitary piece.

18. (Original) The apparatus of claim 1, in which at least a portion of the fiducial marker includes an anti-microbial coating.

19. (Original) The apparatus of claim 1, in which the shaft and the head are made from different materials.

20. (Previously Presented) The apparatus of claim 19, in which the head is made from a material that provides a different imaging contrast than the shaft material.

21. (Original) The apparatus of claim 1, in which the shaft includes a distal means for driving into bone without requiring rotation.

22. (Previously Presented) An apparatus comprising:

a fiducial marker including:

an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone;

wherein the shaft includes a laterally expandable distal tip.

23. (Currently Amended) ~~The apparatus of claim 1, further including~~

An apparatus comprising:

a fiducial marker including:

an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and wherein the conical receptacle has a base at an edge defined by a surface of the locator head and an apex at a center of the locator head to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone; and

a protective cap sized and shaped for protecting the fiducial marker.

24. (Original) The apparatus of claim 23, in which the protective cap engages the head.

25. (Previously Presented) An apparatus comprising:

a fiducial marker including:

an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head;

a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone; and

a protective cap sized and shaped for protecting the fiducial marker;

wherein the protective cap includes a base configured for scalp adhesion.

26. (Previously Presented) An apparatus comprising:

- a fiducial marker including:
 - an imagable fiducial locator head that is locatable by an imaging system, the head being at least semispherical;
 - a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head;
 - a bone screw shaft that extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone; and
- a protective cap sized and shaped for protecting the fiducial marker;

wherein the protective cap fits about the shaft.

27. (Original) The apparatus of claim 26, in which the protective cap comprises:

- a disk-like base, including a center orifice; and
- a circumferential peripheral cylindrical sidewall.

28. (Original) The apparatus of claim 27, in which the protective cap comprises at least one radial slot in the base from the orifice.

29. (Original) The apparatus of claim 28, in which the protective cap comprises a peripheral sidewall slot aligned to the radial slot.

30. (Original) The apparatus of claim 27, further comprising a disk-like cap sized and shaped to fit over a proximal portion of the sidewall.

31. (Original) The apparatus of claim 1, further comprising a headband sized and shaped for protecting at least one fiducial marker.

32. (Currently Amended) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head wherein the conical receptacle has a base at an edge of a surface of the fiducial location head and a substantially continuously sloping wall to an apex of the conical receptacle; and

a bone screw shaft that extends outward from and is formed as an unitary single piece with the imagable fiducial locator head;

wherein at least a portion of the bone screw shaft being configured for being directly secured to the bone.

33. (Original) The apparatus of claim 32, in which the receptacle includes an inverted substantially conical divot.

34. (Original) The apparatus of claim 32, in which the at least one slot includes four slots distributed about a proximal side of the imagable fiducial locator head and extending through respective portions of the imagable fiducial locator head to intersect the divot.

35. (Previously Presented) The apparatus of claim 32, in which the at least the portion of the bone screw shaft is externally threaded and is self tapping.

36. (Previously Presented) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator, the shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone;

in which at least a portion of the bone screw shaft is externally threaded and includes a quarter cylindrical cutout extending from a distal tip of the shaft.

37. (Previously Presented) The apparatus of claim 32, in which the shaft includes an unthreaded portion separating an externally threaded portion of the shaft from the imagable fiducial locator head.

38. (Original) The apparatus of claim 37, further including a seat where the unthreaded portion of the shaft meets the externally threaded portion of the shaft.

39. (Original) The apparatus of claim 38, in which the seat includes a groove.

40. (Original) The apparatus of claim 32, further including an imagable plug, sized and shaped to fit within the receptacle.

41. (Original) The apparatus of claim 32, further including a cover sized and shaped to fit over the imagable fiducial locator head.

42. (Original) The apparatus of claim 32, further including an imagable coating on at least a portion of the imagable fiducial locator head.

43. (Original) The apparatus of claim 32, in which at least a portion of the bone screw shaft includes a bone cutting edge.

44. (Canceled)

45. (Original) The apparatus of claim 32, in which at least a portion of the fiducial marker includes an anti-microbial coating.

46. (Original) The apparatus of claim 32, in which the shaft and the head are made from different materials.

47. (Original) The apparatus of claim 46, in which the head is made from a material that provides a different imaging contrast than the shaft material.

48. (Original) The apparatus of claim 32, in which the shaft includes a distal means for driving into bone without requiring rotation.

49. (Previously Presented) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator, the shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone;

wherein the shaft includes a laterally expandable distal tip.

50. (Original) The apparatus of claim 32, further including a protective cap sized and shaped for protecting the fiducial marker.

51. (Original) The apparatus of claim 50, in which the protective cap engages the head.

52. (Previously Presented) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head;

a bone screw shaft that extends outward from the imagable fiducial locator, the shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone; and

a protective cap sized and shaped for protecting the fiducial marker;

in which the protective cap includes a base configured for scalp adhesion.

53. (Previously Presented) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a conical receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head and configured to permit access to a center of the imagable fiducial locator head;

a bone screw shaft that extends outward from the imagable fiducial locator, the shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone; and

a protective cap sized and shaped for protecting the fiducial marker;

in which the protective cap fits about the shaft.

54. (Original) The apparatus of claim 53, in which the protective cap comprises:

a disk-like base, including a center orifice; and

a circumferential peripheral cylindrical sidewall.

55. (Original) The apparatus of claim 54, in which the protective cap comprises at least one radial slot in the base from the orifice.

56. (Original) The apparatus of claim 55, in which the protective cap comprises a peripheral sidewall slot aligned to the radial slot.

57. (Original) The apparatus of claim 54, further comprising a disk-like cap sized and shaped to fit over a proximal portion of the sidewall.

58. (Original) The apparatus of claim 32, further comprising a headband sized and shaped for protecting at least one fiducial marker.

59. (Currently Amended) A method comprising:

driving directly into a bone of a patient a fiducial marker device including both at least a semispherical imagable locator head and an integral conical receptacle sized and shaped for mating to an instrument detectable by a positioning system and configured to permit access to a center of the imagable fiducial locator head;

obtaining, using an imaging system, an image of the patient, including the imagable locator head; and

~~forming~~ providing an apex of the conical receptacle at the center;

providing a substantially continuous wall from an edge defined by a surface of the locator head to the apex of the conical receptacle;

accessing the apex with the instrument by moving the instrument towards the apex while the instrument is substantially angled relative to an axis along the height of the integral conical receptacle;

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient.

60. (Original) The method of claim 59, further comprising introducing a fluid or gel into association with a portion of the imagable locator head before the obtaining the image of the patient.

61. (Original) The method of claim 60, further comprising positioning a cover about the imagable locator head.

62. (Original) The method of claim 59, further including drilling a hole into the bone before the driving, and wherein the driving includes screwing into the hole.

63. (Original) The method of claim 59, further including placing a cap in a divot of a fiducial marker.

64. (Previously Presented) A method comprising:

driving directly into a bone of a patient a fiducial marker device including both an at least semispherical imagable locator head and an integral conical receptacle sized and shaped for mating to an instrument detectable by a positioning system and configured to permit access to a center of the imagable fiducial locator head;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head;

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient; and

laterally expanding a distal portion of the fiducial marker device to assist in affixing the fiducial marker device to the bone.

65. (Previously Presented) A method comprising:

driving directly into a bone of a patient a fiducial marker device including both an at least semispherical imagable locator head and an integral conical receptacle sized and shaped for mating to an instrument detectable by a positioning system and configured to permit access to a center of the imagable fiducial locator head;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head;

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient; and

disposing a protective collar into association with the fiducial marker device.

66. (Original) The method of claim 65, further including capping the collar to at least partially house the fiducial marker device.

67. (Original) The method of claim 59, further including disposing a guide collar about the fiducial marker device before the driving.

68. (Previously Presented) A method comprising:

driving directly into a bone of a patient a fiducial marker device including both an at least semispherical imagable locator head and an integral conical receptacle sized and shaped for mating to an instrument detectable by a positioning system and configured to permit access to a center of the imagable fiducial locator head;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head;

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient;

disposing a guide collar about the fiducial marker device before the driving; and

leaving the guide collar about the fiducial marker during a time period in which the patient is to be protected against a mechanical impact to the fiducial marker.

69. (Original) The method of claim 68, further comprising removing at least a portion of the guide collar axially from the fiducial marker.

70. (Original) The method of claim 68, further comprising removing at least a portion of the guide collar laterally from the fiducial marker.

71-75. (Canceled)

76. (Previously Presented) An apparatus comprising:

- a fiducial marker including:
 - an imagable fiducial locator head that is locatable by an imaging system;
 - a male or female receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head; and
 - a bone screw shaft extends outward from the imagable fiducial locator head, at least a portion of the bone screw shaft is configured for being secured to a bone; and
 - a protective cap sized and shaped for protecting the fiducial marker, the protective cap configured to fit about the bone screw shaft.

77. (Previously Presented) The apparatus of claim 76, in which the protective cap comprises:

- a disk-like base, including a center orifice; and
- a circumferential peripheral cylindrical sidewall.

78. (Previously Presented) The apparatus of claim 77, in which the protective cap comprises at least one radial slot in the base from the orifice.

79. (Previously Presented) The apparatus of claim 78, in which the protective cap comprises a peripheral sidewall slot aligned to the radial slot.

80. (Previously Presented) The apparatus of claim 77, further comprising a disk-like cap sized and shaped to fit over a proximal portion of the sidewall.

81. (Previously Presented) An apparatus comprising:
a fiducial marker including:
an imagable fiducial locator head that is locatable by an imaging system;
a male or female receptacle that is sized and shaped for engaging a
locator instrument of a positioning system, the receptacle integrated with the imagable
fiducial locator head; and
a bone screw shaft extends outward from the imagable fiducial locator
head, at least a portion of the bone screw shaft is configured for being secured to a
bone, the shaft including a laterally expandable distal tip.

82. (Previously Presented) The apparatus of claim 81, in which the
receptacle includes a substantially conical divot including an apex that is integrally
located, with respect to the imagable fiducial locator head, such that a center of an
image of the imagable fiducial locator substantially coincides with the apex of the divot.

83. (Previously Presented) The apparatus of claim 81, further including at
least one slot in the imagable fiducial locator head, the at least one slot being sized and
shaped for receiving a blade or tip of a screwdriver for turning and threading the bone
screw shaft into the bone.

84. (Previously Presented) The apparatus of claim 81, in which the
imagable fiducial locator includes a reflective outer surface that reflects electromagnetic
energy.

85. (Previously Presented) The apparatus of claim 81, in which the imagable fiducial locator is locatable by at least two different imaging modalities.

86. (Previously Presented) The apparatus of claim 81, in which the imagable fiducial locator includes a hygroscopic material.

87. (Previously Presented) The apparatus of claim 81, further including an imagable plug, sized and shaped to fit within the receptacle.

88. (Previously Presented) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head to permit access to a center of the imagable fiducial locator head; and

a bone screw shaft that extends outward from the imagable fiducial locator, the shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone, at least a portion of the bone screw shaft that being externally threaded and including a quarter cylindrical cutout extending from a distal tip of the shaft.

89. (Previously Presented) The apparatus of claim 88, further including an imagable plug, sized and shaped to fit within the receptacle.

90. (Previously Presented) The apparatus of claim 88, further including a cover sized and shaped to fit over the imagable fiducial locator head.

91. (Currently Amended) An apparatus comprising:

a fiducial marker including:

a substantially spherical imagable fiducial locator head that is locatable by an imaging system, the imagable fiducial locator head including at least one slot for driving the fiducial marker to secure it to a bone;

a receptacle that is sized and shaped for engaging a locator instrument of a positioning system, the receptacle integrated with the imagable fiducial locator head to permit access to a center of the imagable fiducial locator head; [[and]]

a bone screw shaft that extends outward from the imagable fiducial locator, the bone screw shaft integrated with the imagable fiducial locator head, at least a portion of the bone screw shaft being configured for being directly secured to the bone, the bone screw shaft including an externally unthreaded portion separating an externally threaded portion of the bone screw shaft from the imagable fiducial locator head; and

an imagable plug, sized and shaped to fit within the receptacle.

92. (Previously Presented) The apparatus of claim 91, further including a seat where the unthreaded portion of the shaft meets the externally threaded portion of the shaft; wherein the seat is defined as the unthreaded portion defining an external diameter greater than a major diameter of the threaded portion to define a depth stop of the fiducial marker.

93. (Previously Presented) The apparatus of claim 92, in which the seat includes a groove.

94. (Previously Presented) A method comprising:

driving directly into a bone of a patient a fiducial marker device including both an imagable locator head and an integral male or female receptacle sized and shaped for mating to an instrument detectable by a positioning system;

laterally expanding a distal portion of the device to assist in affixing the fiducial marker device to the bone;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head; and

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient.

95. (Previously Presented) The method of claim 94, further comprising positioning a cover about the imagable locator head.

96. (Previously Presented) The method of claim 94, further including drilling a hole into the bone before the driving, and wherein the driving includes screwing into the hole.

97. (Previously Presented) The method of claim 94, further including placing a cap in a divot of a fiducial marker.

98. (Previously Presented) A method comprising:

disposing a guide collar about the fiducial marker device and leaving the guide collar about the fiducial marker during a time period in which the patient is to be protected against a mechanical impact to the fiducial marker;

driving directly into a bone of a patient a fiducial marker device including both an imagable locator head and an integral male or female receptacle sized and shaped for mating to an instrument detectable by a positioning system;

removing at least a portion of the guide collar axially from the fiducial marker;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head; and

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient.

99. (Previously Presented) The method of claim 98, further including drilling a hole into the bone before the driving, and wherein the driving includes screwing into the hole.

100. (Previously Presented) The method of claim 98, further including placing a cap in a divot of a fiducial marker.

101. (Previously Presented) A method comprising:

disposing a guide collar about the fiducial marker device and leaving the guide collar about the fiducial marker during a time period in which the patient is to be protected against a mechanical impact to the fiducial marker;

driving directly into a bone of a patient a fiducial marker device including both an imagable locator head and an integral male or female receptacle sized and shaped for mating to an instrument detectable by a positioning system;

removing at least a portion of the guide collar laterally from the fiducial marker;

obtaining, using an imaging system, an image of the patient, the image including the imagable locator head; and

mating the instrument to the receptacle to register an actual position of the patient to the image of the patient.

102. (Previously Presented) The method of claim 101, further including drilling a hole into the bone before the driving, and wherein the driving includes screwing into the hole.

103. (Previously Presented) The method of claim 101, further including placing a cap in a divot of a fiducial marker.

104. (New) The apparatus of claim 91, wherein the receptacle includes a substantially continuously sloping wall to an apex at a center of the fiducial locator head from a base at an edge defined by a surface of the fiducial locator head.